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CONCLUSION OF PROF. BALFOUR STEWART'S ADDRESS.

(Continued from page 119.)

The Kew observations are not yet finally reduced, but already several important conclusions have been obtained from them by Mr. De la Rue and the other Kew observers. In the first place the Kew photographs confirm the theory of Wilson that sun-spots are phenomena, the dark portions of which exist at a level considerably beneath the general surface of the sun; in other words, they are hollows, or pits, the interior of which is of course filled up with the solar atmosphere. The Kew observers were likewise led to associate the low temperature of the bottom of sun-spots with the downward carriage of colder matter from the atmosphere of the sun, while the upward rush of heated matter was supposed to account for the faculæ or bright patches which almost invariably accompany spots. In the next place the Kew observers, making use not only of the Kew series but of those of Schwabe and Carrington, which were generously placed at their disposal, have discovered traces of the influence of the nearer planets upon the behaviour of sun-spots. This influence appears to be of such a nature that spots attain their maximum size when carried by rotation into positions as far as possible remote from the influencing planet—that is to say into positions where the body of the sun is between them and the planet. There is also evidence of an excess of solar action when two influential planets come near together. But although considerable light has thus been thrown on the periodicity of sun-spots, it ought to be borne in mind that the cause of the remarkable period of eleven years and a quarter, originally discovered by Schwabe, has not yet been properly explained. The Kew observers have likewise discovered traces of a peculiar oscillation of spots between the two hemispheres of the sun, and finally their researches will place at the command of the observers the data for ascertaining whether centres of greater and lesser solar activity are connected with certain heliocentric positions.

While the sun's surface was thus being examined both telescopically and photographically, the spectroscope came to be employed as an instrument of research. It had already been surmised by Prof. Stokes, that the vapour of sodium at a comparatively low temperature, forms one of the constituents of the solar atmosphere, inasmuch as the dark line D in the spectrum of the sun coincides in position with the bright line given out by incandescent sodium vapour.

This method of research was greatly extended by Kirchhoff, who soon found that many of the dark lines in the solar spectrum were coincident with the bright lines of sundry incandescent metallic vapours, and a good beginning was thus made towards ascertaining the chemical constitution of the sun.

The new method soon brought forth further fruit when applied in the hands of Huggins, Miller, Secchi, and others, to the more distant heavenly bodies. It was speedily found that the fixed stars had constitutions very similar to that of the sun. But a peculiar and unexpected success was attained when some of the nebulæ were examined spectroscopically. To-day it seems (so rapidly has knowledge progressed) very much like recalling an old superstition to remind you that

until the advent of the spectroscope the irresolvable nebulæ were considered to be gigantic and remote clusters of stars, the individual members of which were too distant to be separated from each other even with a telescope like that of Lord Rosse. But Mr. Huggins, by means of the spectroscope, soon found that this was not the case, and that most of the nebulæ which had defied the telescope gave indications of incandescent hydrogen gas. It was also found by this observer that the proper motions of some of the fixed stars in a direction to or from the earth might be detected by means of the displacement of their spectral lines, a method of research which was first enunciated by Fizeau. Hitherto in such applications of the spectroscope, the body to be examined was viewed as a whole. It had not yet been attempted to localise the use of this instrument so as to examine particular districts of the sun, as for instance a sun-spot, or the red flames already proved by De La Rue to belong to our luminary. This application was first made by Mr. Lockyer, who in the year 1865 examined a sun-spot spectroscopically and remarked the greater thickness of the lines in the spectrum of the darker portion of the spot.

Dr. Frankland had previously found that thick spectral lines correspond to great pressure, and hence the inference from the greater thickness of lines in the umbra of a spot is, that this umbra or dark portion is subject to a greater pressure; that is to say, it exists below a greater depth of the solar atmosphere than the general surface of the sun. Thus the results derived from the Kew photoheliograph and those derived from the spectroscope were found to confirm each other. Mr. Lockyer next caused a powerful instrument to be constructed for the purpose of viewing spectroscopically the red flames round the sun's border, in the hope that if they consisted of ignited gas the spectroscope would disperse, and thus dilute and destroy the glare which prevents them from being seen on ordinary occasions.

Before this instrument was quite ready, these flames had been analysed spectroscopically by Capt. Herschell, M. Janssen, and others, on the occasion of a total eclipse occurring in India, and they were found to consist of incandescent gas, most probably hydrogen. But the latter of these observers (M. Janssen) made the important observation that the bright lines in the spectrum of these flames remained visible even after the sun had reappeared, from which he argued that a solar eclipse is not necessary for the examination of this region.

Before information of the discovery made by Janssen had reached this country, the instrument of Mr. Lockyer had been completed, and he also found that by its means he was able to analyse at leisure the composition of the red flames without the necessity of a total eclipse. An atmosphere of incandescent hydrogen was found to surround our luminary into which, during the greater solar storms, sundry metallic vapours were injected, sodium, magnesium, and iron forming the three that most frequently made their appearance.

Here we come to an interesting chemical question.

It had been remarked by Maxwell and by Pierce as the result of the molecular theory of gases that the final distribution of any number of kinds of gas in a vertical direction under gravity is such that the density of each gas at a given height is the same as if all the other gases had been removed, leaving it alone. In our own atmosphere the continual disturbances prevent this arrangement from taking place, but in the sun's enormously extended atmosphere (if indeed our luminary be not nearly all gaseous) it appears to hold, inasmuch as the upper portion of this atmosphere, dealing with known elements, apparently consists entirely of hydrogen. Various other vapours are, however, as we have seen, injected from below the photosphere into the solar atmosphere on the occasion of great disturbances, and Mr. Lockyer has asked the question, whether we have not here a true indication of the relative densities of these various vapours derived from the relative heights to which they are injected on such occasions

This question has been asked, but it has not yet received a definite solution, for chemists tell us that the vapour densities of some of the gases injected into the sun's atmosphere on the occasion of disturbances are, as far as they know from terrestrial observations, different from those which would be indicated by taking the relative heights attained in the atmosphere of the sun. Mr. Lockyer

has attempted to bring this question a step nearer to its solution by showing that the vapours at the temperatures at which their vapour densities have been experimentally determined are not of similar molecular constitution, whereas in the sun we get an indication, from the fact that all the elements give us line spectra, that they are in similar molecular states.

Without, however, attempting to settle this question, I may remark that we have here an interesting example of how two branches of science—physics and chemistry—meet together in solar research.

It had already been observed by Kirchhoff that sometimes one or more of the spectral lines of an elementary vapour appeared to be reversed in the solar spectrum, while the other lines did not experience reversal. Mr. Lockyer succeeded in obtaining an explanation of this phenomenon. This explanation was found by means of the method of localization already mentioned.

Hitherto, when taking the spectrum of the electric spark between the two metallic poles of a coil, the arrangements were such as to give an average spectrum of the metal of these poles; but it was found that when the method of localisation was employed, different portions of the spark gave a different number of lines, the regions near the terminals being rich in lines, while the midway regions give comparatively few.

If we imagine that in the midway regions the metallic vapour given off by the spark is in a rarer state than that near the poles, we are thus led to regard the short lines which cling to the poles as those which require a greater density or nearness of the vapour particles before they make their appearance; while on the other hand, those which extend all the way between the two poles come to be regarded as those which will continue to make their appearance in vapour of great tenuity.

Now it was remarked that these long lines were the very lines which were reversed in the atmosphere of the sun. Hence when we observe a single coincidence between a dark solar line and the bright line of any metal, we are further led to enquire whether this bright line is one of the long lines which will continue to exist all the way between two terminals of that metal when the spark passes.

If this be the case, then we may argue with much probability that the metal in question really occurs in the solar atmosphere; but if, on the other hand, the coincidence is merely between a solar dark line and a short bright one, then we are led to imagine that it is not a true coincidence, but something which will probably disappear on further examination. This method has already afforded us a means of determining the relative amount of the various metallic vapours in the sun's atmosphere. Thus, in some instances, all lines are reversed, whereas in others the reversal extends only to a few of the longer lines.

Several new metals have thus been added to the list of those previously detected in the solar atmosphere, and it is now certain that the vapours of hydrogen, potassium, sodium, rubidium, barium, strontium, calcium, magnesium, aluminium, iron, manganese, chromium, cobalt, nickel, titanium, lead, copper, cadmium, zinc, uranium, cerium, vanadium, and palladium occur in our luminary.

I have spoken hitherto only of telescopic spectroscopy; but photography has been found capable of performing the same good service towards the compound instrument consisting of the telescope and its attached spectroscope, which it had previously been known to perform towards the telescope alone. It is of no less importance to secure a permanent record of spectral pecularities than it is to secure a permanent record of telescopic appearances. This application of photography to spectrum observations was first commenced on a sufficient scale by Mr. Rutherford, of New York, and already promises to be one of the most valuable aids in solar inquiry.

In connection with the spectroscope, I ought here to mention the names of Respighi, and Secchi, who have done much in the examination of the solar surface from day to day. It is of great importance to the advancement of our knowledge, that two such competent observers are stationed in a country where the climate is so favourable to continued observation.

The examination of the sun's surface by the spectroscope suggests many interesting questions connected with other branches of science. One of these has already

been alluded to. I may mention two others put by Mr. Lockyer, premising, however, that at present we are hardly in a position to reply to them. It has been asked whether the very high temperatures of the sun and of some of the stars may not be sufficient to produce the disassociation of those molecular structures which cannot be disassociated by any terrestrial means; in other words, the question has been raised, whether our so-called elements are really elementary bodies.

A third question is of geological interest. It has been asked whether a study of the solar atmosphere may not throw some light upon the peculiar constitution of the upper strata of the earth's surface, which are known to be of less density than the average interior of our planet.

If we have learned to be independent of total eclipses as far as the lower portions of the solar atmosphere are concerned, it must be confessed that as yet the upper portions—the outworks of the sun—can only be successfully approached on these rare and precious occasions. Thanks to the various Government expeditions despatched by Great Britain, by the United States, and by several Continental nations—thanks also to the exertions of Lord Lindsay and other astronomers—we are in the possession of definite information regarding the solar corona.

In the first place, we are now absolutely certain that a large part of this appendage unmistakably belongs to our luminary, and in the next place, we know that it consists, in part at least, of an ignited gas giving a peculiar spectrum, which we have not yet been able to identify with that of any known element. The temptation is great to associate this spectrum with the presence of something lighter than hydrogen, of the nature of which we are yet totally ignorant.

A peculiar physical structure of the corona has likewise been suspected. On the whole, we may say that this is the least known, while it is perhaps the most interesting, region of solar research; most assuredly it is well worthy of further investigation.

If we now turn our attention to matters nearer home, we find that there is a difficulty in grasping the facts of terrestrial meteorology no less formidable than that which assails us when we investigate solar outbreaks. The latter perplex us because the sun is so far away, and because also his conditions are so different from those with which we are here familiar; while on the other hand, the former perplex us because we are so intimately mixed up with them in our daily lives and actions; because, in fact, the scale is so large and we are so near. The result has been that until quite recently our meteorological operations have been conducted by a band of isolated volunteers individually capable and skilful, but from their very isolation incapable of combining together with advantage to prosecute a scientific campaign. Of late, however, we have begun to perceive that if we are to make any advance in this very interesting and practical subject, a different method must be pursued, and we have only reaped the first fruits of a more enlightened policy; already we have gained some knowledge of the constitution and habits of our atmosphere.

The researches of Wells and Tyndall have thrown much light upon the cause of dew. Humboldt, Dové, Buys Ballot, Jelinek, Quetelet, Hansteen, Kupffer, Forbes, Welsh, Glaisher, and others have done much to give us an accurate knowledge of the distribution of terrestrial temperature. Great attention has likewise been given to the rainfall of Great Britain and Ireland, chiefly through the exertions of one individual, Mr. G. J. Symons.

To Dové we are indebted for the law of rotation of the wind, to Redfield for the spiral theory of cyclones, to Francis Galton for the theory of anti-cyclones, to Buchan for an investigation into the disposition of atmospheric pressure which precedes peculiar types of weather, to Stephenson for the conception of barometric gradients, to Scott and Meldrum for an acquaintance with the disposition of winds which frequently precedes violent outbreaks; and to come to the practical application of laws, we are much indebted to the late Admiral Fitzroy and the system which he greatly helped to establish for our telegraphic warnings of coming storms.

Again, the meteorology of the ocean has not been forgotten. The well-known name of Maury will occur to everyone as that of a pioneer in this branch of inquiry. Fitzroy, Leverrier, Meldrum, Toynbee, and others have likewise done

much; and it is understood that the meteorological offices of this and other maritime countries are now busily engaged upon this important and practical subject. Finally, the movements of the ocean and the temperatures of the oceanic depths have recently been examined with very great success in vessels despatched by her Majesty's Government; and Dr. Carpenter has by this means been able to throw great light upon the convection currents exhibited by that vast body of water which girdles our globe.

It would be out of place to enter here more minutely into this large subject, and already it may be asked what connection has all this with that part of the address that went before it.

There are, however, strong grounds for supposing that the meteorology of the sun and that of the earth, are intimately connected together. Mr. Broun has shown the existence of a meteorological period connected apparently with the sun's rotation; five successive years' observations of the barometer at Singapore all giving the period 25·74 days. Mr. Baxendell, of Manchester, was, I believe, the first to show that the convection currents of the earth appear to be connected somehow with the state of the sun's surface as regards spots; and still more recently, Mr. Meldrum, of the Mauritius Observatory, has shown by a laborious compilation of ships' logs and by utilizing the meteorological records of the island, that the cyclones in the Indian Ocean are most frequent in years when there are most sunspots. He likewise affords us grounds for supposing that the rainfall, at least in the tropics, is greatest in years of maximum solar disturbance.

Mr. Poey has found a similar connection in the case of the West Indian hurricanes; and finally, Piazzi Smyth, Stone, Köppen, and still more recently Blandford, have been able to bring to light a cycle of terrestrial temperature having apparent reference to the condition of the sun.

Thus, we have strong matter-of-fact grounds for presuming a connection between the meteorology of our luminary and that of our planet, even although we are in complete ignorance as to the exact nature of this bond.

If we now turn to terrestrial magnetism the same connection becomes apparent.

Sir Edward Sabine was the first to show that the disturbances of the magetism of the earth are most violent during years of maximum sun-spots. Mr. Broun has shown that there is likewise a reference in magnetic phenomena to the period of the sun's rotation about his axis, an observation recently confirmed by Hornstein; and still more recently, Mr. Broun has shown that the moon has an action upon the earth's magnetism which is not altogether of a tidal nature, but depends, in part, at least, upon the relative position of the sun and moon.

I must trust to your forbearance if I now venture to bring forward considerations of a somewhat speculative nature.

We are all familiar with the generalisation of Hadley, that is to say, we know there are under-currents sweeping along the surface of the earth from the poles to the equator, and upper-currents sweeping back from the equator to the poles. We are likewise aware that these currents are caused by the unequal temperature of the earth; they are in truth convection-currents, and their course is determined by the positions of the hottest and coldest parts of the earth's surface. We may expect them, therefore, to have a reference not so much to the geographical equator and poles, as to the hottest and coldest regions. In fact, we know that the equatorial regions into which the trade winds rush, and from which the anti-trades take their origin, have a certain annual oscillation depending upon the position of the sun, or in other words upon the season of the year. We may likewise imagine that the region into which the upper currents pour themselves is not the geographical pole, but the pole of greatest cold.

In the next place we may imagine that these currents, as far as regards a particular place, have a daily oscillation. This has, I believe, been proved as regards the lower currents or trade-winds, which are more powerful during the day than during the night, and we may therefore expect it to hold good with regard to the upper-currents or anti-trades; in fact, we cannot go wrong in supposing that they also, as regards any particular place, exhibit a daily variation in the intensity with which they blow.

Again, we are aware that the earth is a magnet. Let us not now concern ourselves about the origin of its magnetism, but rather let us take it as it is. We must next bear in mind that rarefied air is a good conductor of electricity; indeed, according to recent experiments, an extremely good conductor. The return trades that pass from the hotter equatorial regions to the poles of cold, consisting of moist rarefied air, are therefore to be regarded in the light of good conductors crossing lines of magnetic force; we may therefore expect them to be the vehicle of electric currents. Such electric currents will of course re-act on the magnetism of the earth. Now, since the velocity of these upper currents has a daily variation, their influence as exhibited at any place upon the magnetism of the earth, may be expected to have a daily variation also.

The question thus arises, Have we possibly here a cause which may account for the well-known daily magnetic variation? Are the peculiarities of this variation such as to correspond to those which might be expected to belong to such electric currents? I think it may be said that as far as we can judge, there is a likeness of this kind between the peculiarities of these two things, but a more prolonged scrutiny will of course be essential before we can be absolutely certain that such currents are fitted to produce the daily variation of the earth's magnetism.

Besides the daily and yearly periodic changes in these upper convection currents, we should also expect occasional and abrupt changes forming the counterparts of those disturbances in the lower strata with which we are familiar. And these may be expected in like manner to produce non-periodic occasional disturbances of the magnetism of the earth. Now it is well known that such disturbances do occur, and further that they are most frequent in those years when cyclones are most frequent, that is to say in years of maximum sunspots. In one word, it appears to be a tenable hypothesis to attribute at least the most prominent magnetic changes to atmospheric motions taking place in the upper regions of the atmosphere where each moving stratum of air becomes a conductor moving across lines of magnetic force; and it was Sir Wm. Thompson, I believe, who first suggested that the motion of conductors across the lines of the earth's magnetic force must be taken into account in any attempted explanation of terrestrial magnetism.

It thus seems possible that the excessive magnetic disturbances which take place in years of maximum sunspots may not be directly caused by any solar action, but may rather be due to the excessive meteorological disturbances which are likewise characteristic of such years. On the other hand, that magnetic and meteorological influence which Mr. Broun has found to be connected with the sun's rotation, points to some unknown direct effect produced by our luminary, even if we imagine that the magnetic part of it is caused by the meteorological. Mr. Broun is of opinion that this effect of the sun does not depend upon the amount of spots on his surface.

In the next place, that influence of the sun, in virtue of which we have most cyclones and greater meteorological disturbance in the years of maximum spots, cannot, I think (as far as we know at present), be attributed to a change in the heating power of the sun. We have no doubt traces of a temperature effect which appears to depend upon the sun-period, but its amount is very small, whereas the variation in cyclonic disturbance is very great. We are thus tempted to associate this cyclone producing influence of the sun with something different from his light and heat. As far, therefore, as we can judge, our luminary would appear to produce three distinct effects upon our globe. In the first place, a magnetic and meteorological effect, depending somehow upon his rotation; secondly, a cyclonic effect depending somehow upon the disturbed state of his surface; and lastly, the well-known light and heat effect with which we are all familiar.

If we now turn to the sun we find that there are three distinct forms of motion which animate his surface particles. In the first place, each particle is carried round by the rotation of our luminary. Secondly, each particle is influenced by the gigantic meteorological disturbances of the surface, in virtue of which it may acquire a velocity ranging as high as 130 or 140 miles a second; and lastly, each particle, on account of its high temperature, is vibrating with extreme rapidity,

and the energy of these vibrations communicated to us by means of the ethereal medium produces the well-known light and heat effect of the sun.

Now, is it philosophical to suppose that it is only the last of these three motions that influence our earth, while the other two produce absolutely no effect? On the contrary, we are, I think, compelled by considerations connected with the theory of energy, to attribute an influence, whether great or small, to the first two as well as to the last.

We are thus led to suppose that the sun must influence the earth in three ways, one depending on his rotation, another on his meteorological disturbance, and a third by means of the vibrations of his surface particles.

But we have already seen that, as a matter of fact, the sun does appear to influence the earth in three distinct ways—one magnetically and meteorologically, depending apparently on his period of rotation; a second cyclonically, depending apparently on the meteorological conditions of his surface; and a third, by means of his light and heat.

Is this merely a coincidence, or has it a meaning of its own? We cannot tell; but I may venture to think that in the pursuit of this problem we ought to be prepared at least to admit the possibility of a three-fold influence of the sun.

Even from this very meagre sketch of one of the most interesting and important of physical problems, it cannot fail to appear that while a good deal has already been done, its progress in the future will very greatly depend on the completeness of the method and continuity of the observations by which it is pursued. We have here a field which is of importance not merely to one, or even to two, but almost to every conceivable branch of research.

Why should we not erect in it a sort of science exchange into which the physicist, the chemist, and the geologist may each carry the fruits of his research, receiving back in return some suggestion, some principle, or some other scientific commodity that will aid him in his own field. But to establish such a mart must be a national undertaking, and already several nations have acknowledged their obligations in this respect.

Already the German Government have established a Sonnenwarte, the mere building and equipment of which is to cost a large sum. With an appreciation of what the spectroscope has done for this inquiry, the first directorship was offered to Kirchhoff, and on his declining it, Herr Vogel has been placed in charge. In France, also, a physical observatory is to be erected at Fontenay, on an equal, if not greater scale, of which Janssen has already accepted the directorship; while in Italy there are at least three observatories exclusively devoted to this branch of research. Nor must we forget that in this country the new observatory at Oxford has been so arranged that it can be employed in such inquiries. But what has England as a nation done?

Some years since, at the Norwich meeting of this Association, a movement was set on foot by Col. Strange which resulted in the appointment of a Royal Commission on the advancement of science, with the Duke of Devonshire as chairman. This Commission have quite recently reported on the steps that ought in their opinion to be taken for the advancement of scientific research.

One of their recommendations is expressed in the following words:—

"Important classes of phenomena relating to physical meteorology and to terrestrial and astronomical physics require observations of such a character that they cannot be advantageously carried on otherwise than under the direction of Government. Institutions for the study of such phenomena should be maintained by the Government; and in particular an observatory should be founded specially devoted to astronomical physics."

If the men of science of this country who procured the appointment of this commission, and who subsequently gave evidence before it, will now come forward to support its recommendations, it can hardly be doubted that these will be speedily carried into effect.

But other things besides observations are necessary, if we are to pursue with advantage this great physical problem.

One of these is the removal of the intolerable burden that has hitherto been laid upon private meteorologists and magnetieians. Expected to furnish their

tale of bricks, they have been left to find their own straw. Nothing more wretched can be imagined than the position of an amateur—that is to say, a man who pursues science for the love of it and is unconnected with any establishment —who has set himself to promote observational inquiries, whether in meteorology or magnetism.

He has first to obtain with great expenditure of time or money, or both, copies of the individual observations taken at some recognized institution. He has next to reduce these in the way that suits his inquiry; an operation again consuming time and demanding means. Let us suppose all this to be successfully accomplished, and a valuable result obtained. It is doubtless embodied in the Transactions of some society, but it excites little enthusiasm, for it consists of something which cannot be repeated by every one for himself like a new and interesting experiment. Yet the position of such men has recently been improved. Several observatories and other institutions now publish their individual observations; this is done by our Meteorological Office, while Dr. Bergsma, Dr. Neumayer, and Mr. Broun are recent examples of magneticians who have adopted this plan. The publication of the work of the latter is due to the enlightened patronage of the Rajah of Travancore, who has thus placed himself in front of the princes of India and given them an example which it is to be hoped they will follow. But this is only one step in the right direction; another must consist in subsidising private meteorologists and magneticians in order to enable them to obtain the aid of computers in reducing the observations with which they have been furnished. The man of science would thus be able to devote his knowledge, derived from long study, to the methods by which results and the laws regulating them are to be obtained; he could be the architect and builder of a scientific structure without being forced to waste his energies on the work of a hodman.

Another hindrance consists in our deficient knowledge as to what observations of value in magnetism and meteorology have already been made. We ought to have an exhaustive catalogue of all that has been done in this respect in our globe, and of the conditions under which the various observations will be accessible to outside enquirers. A catalogue of this kind has been framed by a committee of this Association, but it is confined to the dominions of England, and requires to be supplemented by a list of that which has been done abroad.

A third drawback is the insufficient nature of the present facilities for the invention and improvement of instruments, and for their verification.

We have, no doubt, advanced greatly in the construction of instruments, especially in those which are self-recording. The names of Brooke, Robinson, Welsh, Osler, and Beckley, will occur to us all as improvers of our instruments of observation. Sir W. Thompson has likewise adapted his electrometer to the wants of meteorology. Dr. Roscoe has given us a self-recording actinometer, but a good instrument for observing the sun's heat is still a desideratum. It ought likewise to be borne in mind that the standard mercurial thermometer is by no means a perfect instrument.

In conclusion, it cannot be doubted that a great generalisation is looming in the distance—a mighty law we cannot yet tell what, that will reach us we cannot yet say when. It will involve facts hitherto inexplicable, facts that are scarcely received as such because they appear opposed to our present knowledge of their causes. It is not possible perhaps to hasten the arrival of this generalisation beyond a certain point; but we ought not to forget that we *can* hasten it, and that it is our duty to do so. It depends much on ourselves, our resolution, our earnestness; on the scientific policy we adopt, as well as on the power we may have, to devote ourselves to special investigations, whether such an advent shall be realised in our day and generation, or whether it shall be indefinitely postponed. If governments would understand the ultimate *material* advantages of every step forward in science, however inapplicable each may appear for the moment to the wants or pleasures of ordinary life, they would find reasons patent to the meanest capacities for bringing the wealth of mind, now lost on the drudgery of common labours, to bear on the search for those wondrous laws which govern every movement not only of the mighty masses of our system, but of every atom distributed throughout space.

Dr. Moffat, in his paper "On the apparent connection between Sunspots, Atmospheric Ozone, Rain, and Force of Wind," stated that in discussing ozone observations from 1850 to 1869, he had observed that the maxima and minima of atmospheric ozone occurred in cycles of years, and that he had compared the number of new groups of sunspots in each year of these cycles with the quantity of ozone, and the results showed that in each cycle of maxima of ozone there is an increase in the number of new groups of sunspots, and in each cycle of minima a decrease. He also gave the following table to show that the years of maximum ozone and number of sunspots were generally distinguished by an increase in the quantity of rain and the force of the wind.

Mean daily quantity of Ozone for each year, the quantity of Rain, the number of new Groups of Sunspots, and mean daily Force of Wind, from 1850 *to* 1869, *both inclusive.*

Year.	Mean daily quantity of Ozone.	Cycles of max. and min. of Ozone.	No. of new Groups of Sunspots in each year.	Mean No. of new Groups of Sunspots with Cycles of Ozone.	Mean Annual Quantity of Rain with Cycles.
					inches.
1850	2·6		186		
1851	2·7		141		
1852	2·5	2·6	125	122	26·6
1853	2·0		91		
1854	3·4		67		
1855	0·9		28		
1856	0·7		34		
1857	1·2	1·1	98	90	24·4
1858	1·6		202		
1859	2·3		205		
1860	2·2		211		
1861	2·0		204		
1862	2·6	2·4	160	161	25·0
1863	3·5		124		
1864	2·0		130		
1865	2·4		93		
1866	1·7		45		
1867	1·5		25		
1868	1·7	1·6	101	99	29·4
1869	2·0		224	Rain this year	33·1

In the years 1867, 1868, and 1869 the rule with regard to rain does not hold good; this is owing to the great increase of sunspots and rain in 1869. It will be observed that the quantity of ozone increased with the increase in the number of new groups of sunspots.

In the years in which the mean number of new groups of sunspots is 174, the mean quantity of rain is 27·0 in.

In the years in which the mean number of new groups of sunspots is 65, the mean quantity of rain is 25·7 in.

In the years in which the number of new groups of sunspots is 174, the mean daily force of wind is 2·0.

In the years in which the number of new groups of sunspots is 65, the mean daily force of wind is 1·7.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS AT TOKEI, JAPAN, 1874.

Lat. 35°; Lon. 139°; height of rain gauge above ground 33 ft.; above sea 50 ft.
Observer,— JOYNER, Esq., C.E.

	Rain.	Shade Temperature.		
		8 a.m.	2 p.m.	8 p.m.
	in.	deg.	deg.	deg.
January	2·38	32·8	42·7	36·5
February	2·18	35·6	45·9	39·8
March	7·57	42·7	50·0	45·2
April	4·65	52·3	60·5	53·4
May	6·49	61·4	68·9	61·9
June	9·88	71·7	77·2	70·3
July	5·34	76·4	81·2	73·8
August	3·29	80·8	82·2?	75·9?
September	9·74	69·5	76·1	69·4
October	10·19	56·1	63·6	57·3
November	2·56	43·8	54·7	47·6
December	5·80	36·3	47·0	40·8
Total	70·07	...	...	...
Mean per Month	5·84	54·9	62·5	56·0

REMARKS.—Typhoon on September 12th and 13th, with 2·25 in. of rain on 12th, and 3·00 in. on 13th. Min. observed temp. 19° on January 20th. Max. observed temp. 91° on August 18th; the latter is the 8 a.m. entry on that date, there being no afternoon observation; the true max. was probably higher.

THE RAINFALL AND FLOODS OF OCTOBER 9TH.

[THE republication of the following letter from the *Times* of October 13th may be permitted, on account of the condensed information it affords.—ED.]

Mr. G. J. Symons, 62, Camden-square, writes to us as follows:—"Considering the exceptional character of the rainfall and floods of July last even in the Midland district, it was scarcely to be expected that within two months, parts of those counties would be visited by a still greater rainfall. Such, however, has been the case, and I am glad to be able to furnish an account of what occurred, accurate, I believe, in all respects, and requiring only unimportant additions to render it complete. I purpose giving, first, the numerical facts; secondly, abstracts of the observers' remarks; and, lastly, a word or two of my own.

RAINFALL BETWEEN OCTOBER 9th, 9 A.M., AND OCTOBER 10th, 9 A.M.

Station.	County.	Depth. Inches.	Station.	County.	Depth. Inches.
Bath	Somerset	0·95	High St., Banbury.	Oxford	3·25
Marlborough	Wilts	1·32	King's Sutton, ,,	Northampton	3·08
Stroud	Gloucester	1·39	Northampton	,,	1·75
Minchinhampton	,,	1·65	Leamington	Warwick	1·63
Abingdon	Berks	1·44	Coventry	,,	1·70
Oxford	Oxford	1·94	Lutterworth	Leicester	2·12
Aylesbury	Bucks	1·50	Market Harborough	,,	2·15
Hereford	Hereford	1·06	Leicester	,,	2·17
Evesham	Worcester	1·88	Moseley	Worcester	1·22
Upper Heyford	Oxford	2·50	Tamworth	Stafford	1·14
Broughton, Banbury	,,	2·95	Wisbeach	Cambridge	0·31

OBSERVERS' NOTES.

Long Wittenham, Abingdon.—Rain all fell between noon and midnight, heaviest between 2 and 3 p.m. Heavy and sudden flood in the Upper Thames.

Hereford.—Nearly all fell before 9 p.m.

Evesham.—Rain commenced at 9 a.m. on Saturday, and fell without intermission until 11 p.m., the heaviest consecutive fall in ten years. The Avon rose rapidly, reached a *maximum* height of 9ft. 3in. above mean level on the 11th, at 6 p.m., and remained at that height with little variation for 24 hours. Rain began from N.E., and backed with the wind to W. at night, when it ceased. All the roads and meadows by the river are under water.

Upper Heyford.—The heaviest fall for at least ten years.

High Street, Banbury.—Highest flood known.

Broughton, Banbury.—Since August 1, 1867, the only falls of, or exceeding, 1½ in. have been,—1867, Aug. 15, 1·75; 1871, Sept. 29, 1·65; 1875, July 14, 1·50; July 20, 1·62; Oct. 9, 2·95; the fall of Saturday was, therefore, more than an inch in excess of any previously recorded.

Coventry.—The greatest fall here for at least nine years.

Ashby Parva, Lutterworth.—Upper and lower currents in nearly opposite directions, and great darkness when the rain began at 1 p.m.

Moseley, Birmingham.—Rain began at 11 a.m. on the 9th, and lasted just 12 hours. During the previous night the wind backed from S. through E. to N.E., and it was N.N.E. when the rain began, W. when it ended.

Wisbeach.—Rain only began at 11 p.m. on the 9th, and ended at 2 a.m. on the 10th, when there was a N.W. gale, pressure 6lb. on square foot.

SUMMARY.

The leading facts may be stated in a very few words. The fall was unusually heavy in Warwickshire, Leicestershire, and part of Worcestershire, and in the north of Oxfordshire and the south of Northamptonshire it was unprecedented. It is a remarkable and at present unexplained circumstance that, with only two intervening years, we have the two years 1872 and 1875, the former with a total fall of rain unequalled during the present century, and the latter with perhaps no very large total amount, but with torrential falls beyond all precedent."

EARTHQUAKE.

To the Editor of the Meteorological Magazine.

SIR,—We had a slight shock of earthquake in Upper Wensleydale, Yorkshire, N.R., at 10 p.m., on the 23rd of September. I have not seen any notice in the papers, so that the tremor may not have ex-

tended to any great distance. I mention it, therefore, in case no other correspondent may send you a note of it. There was a sound as of deep growling thunder, such as sometimes follows the sharper rattle, and shakes one's windows. Along with the rumbling noise there was a distinct vibration, causing the house and floor to shake perceptibly. I think it continued about three seconds. My wife felt it also; and I have since found that others in this neighbourhood have no doubt about its being an earthquake. A lady, *e.g.*, heard the china knick-knacks jingle in her room; and a gentleman six miles down the dale perceived it as he sat in his library, his dog at the same time jumping up on the hearthrug in evident alarm. Earthquakes are very uncommon in this part of the country.

By the way, in my register I have used to denote an Earthquake the usual symbol for earth, circle with diameter, and a wavy line touching circumference at top. I may say too that for Shooting Stars I put an arrow pointing downwards at an angle, with a star for feather. I do not know whether there are better symbols.—Yours truly,

J. D. P.

October 1st, 1875.

SUPPLEMENTARY TABLE OF RAINFALL IN SEPT., 1875.

[For the Counties, Divisions, Latitudes, and Longitudes of these Stations, see Met. Mag., Vol. X., p. 28.]

Station.	Total Rain.	Station.	Total Rain.
	in.		in.
Acol	1·80	Gainford	3·17
Hailsham	2·43	Shap	5·77
Strathfield Turgiss	1·90	Llanfrechfa	4·68
Addington Manor	2·37	Castle Malgwyn	4·67
Oxford	1·94	Heyope	4·34
Cambridge	2·37	Melrose	3·31
Sheering	2·84	Cessnock, Glasgow	4·94
Ipswich	2·44	Gruinart	3·41
Diss	2·44	Keith	4·73
Swaffham	2·40	Strathconan	3·66
Compton Bassett	3·08	Springfield, Tain	2·14
Hessary Tor, Dartmoor	6·12*	Skibbereen	8·30
Teignmouth	4·02	Glenville	8·29
Torrington	7·08	Kilrush	5·98
Trevarrick, St. Austell	...	Kilkenny	5·66
Taunton	2·84	Kilsallaghan	4·45
Cheadle	4·62	Twyford, Athlone	4·97
Ashby de la Zouch	3·28	Ballinasloe	5·54
Coston, Melton Mowbray	2·19	Kylemore	9·40
Bucknall	1·49	Bangor	4·81
Mansfield	2·95	Carrick on Shannon	4·73
Walton, Liverpool	5·05	Warrenpoint	8·40
Broughton-in-Furness	7·78	Bushmills	3·98
Stanley, Wakefield	2·70		

* Not reliable having been tampered with, probably 2 in. too little.

SEPTEMBER, 1875.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1860–5	Greatest Fall in 24 hours. Dpth	Date.	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Date.	Min. Deg.	Date.	No. of Nights below 32°. In shade	On grass
			inches	inches.	in.								
I.	ENGLAND.	Camden Town	2·86	+ ·60	·78	23	15	80·8	18	44·2	29	0	0
II.		Maidstone (Linton Park)	2·20	— ·02	·54	22	11	86·0	18	46·0	29	0	...
,,		Selborne (The Wakes)	1·87	— ·57	·49	21	11	75·0	18	42·5	10	0	0
III.		Hitchen	2·07	+ ·21	·78	23	14	71·0	18*	43·0	28	0	...
,,		Banbury	2·38	+ ·01	·89	21	14	75·5	19	44·0	10	0	..
IV.		Bury St. Edmunds (Culford).	2·67	+ 1·06	·85	21	11	78·0	18*	43·0	28	0	0
V.		Bridport	3·35	+ 1·03	1·05	21	16	74·0	13	40·0	6‡	0	...
,,		Barnstaple	5·53	+ 1·77	1·30	17	18	79·0	8	47·0	9	0	...
,,		Bodmin	7·64	+ 3·97	2·74	17	17	76·0	13	46·0	11	0	0
VI.		Cirencester	2·80	— ·06	·77	21	11	...	...	...	...	...	...
,,		Shifnal (Haughton Hall)	4·14	+ 2·19	·83	19	16	72·0	7	42·0	29	0	0
,,		Tenbury (Orleton)	3·26	+ ·58	·69	23	17	75·7	17	37·7	29	0	0
VII.		Leicester (Belmont Villas)	2·77	...	·78	21	15	81·0	19	42·0	10	0	0
,,		Boston	2·24	+ ·67	·60	21	14	76·0	19	44·0	29	0	...
,,		Grimsby (Killingholme)	2·48	...	·63	21	13	70·5	7	43·0	29	0	...
VIII.		Manchester	4·74	+ 1·05	1·00	8	14	74·2	13	44·3	12	0	0
IX.		York	2·23	— ·10	·83	3	7	72·0	17	41·0	21	0	0
,,		Skipton (Arncliffe)	5·23	+ ·27	1·25	2	19	78·0	12	34·0	28	0	...
X.		North Shields	2·59	+ ·89	·71	8	15	70·3	7	41·8	30	0	0
,,		Borrowdale (Seathwaite)	14·45	+ 1·24	3·04	2	18	...	...	...	...	...	...
XI.	WALES.	Cardiff (Ely)	...	...	...	...	...	...	...	...	...	...	...
,,		Haverfordwest	6·29	+ 2·58	1·81	2	14	72·0	13	40·0	10	0	...
,,		Rhayader (Cefnfaes)	...	...	..	...	...	...	...	..	...	...	...
,,		Llandudno	4·65	+ 2·31	·85	2	16	78·0	7	47·7	11	0	...
XII.	SCOTLAND.	Dumfries (Crichton Asylum)	5·43	...	1·88	2	17	75·0	14	38·0	23	0	...
,,		Hawick (Silverbut Hall)	3·48	...	·86	3	13	...	...	...	...	...	...
XIV.		Kilmarnock (Annanhill)	5·66	...	2·24	26	15	73·8	14	40·5	23	0	0
XV.		Castle Toward	4·69	+ ·07	1·40	3	10	73·0	13	...	...	...	..
XVI.		Leven (Nookton)	3·05	+ ·57	·99	8	14	73·0	12	38·0	1	0	1
,,		Stirling (Deanston)	...	...	...	...	...	..	...	...	..	...	...
,,		Grandtully	3·29	...	1·30	8	9	...	...	..	...	...	...
XVII.		Braemar	4·12	+ 1·48	1·70	26	15	72·0	12	31·0	1	1	5
,,		Aberdeen	5·63	...	1·75	26	17	70·9	12	37·3	23	0	2
XVIII		Loch Broom	4·05	...	1·12	26	12	...	...	...	...	...	...
,,		Portree	4·76	— 6·00	1·23	25	17	...	...	...	...	...	...
,,		Inverness (Culloden)	2·65	— ·04	·95	27	15	72·7	12	36·4	1	0	3
XIX.		Helmsdale	1·88	...	·31	2	14	...	...	...	...	...	...
,,		Sandwick	2·86	— ·80	1·50	26	13	65·0	8	36·8	22	0	2
XX.	IRELAND.	Caherciveen Darrynane Abbey	10·61	...	2·13	21	17	...	...	...	...	...	...
,,		Cork	6·48	...	1·53	26	14	...	...	...	..	...	...
,,		Waterford	5·56	+ 2·43	1·00	22	14	70·0	13	44·0	12	0	0
,,		Killaloe	7·45	+ 3·29	1·65	26	20	76·0	1	37·0	10	0	...
XXI.		Portarlington	5·62	+ 2·34	1·56	27	27	71·0	7	40·0	11	0	...
,,		Monkstown, Dublin	3·61	+ 1·62	·71	23	13	...	...	...	...	...	...
XXII.		Galway	...	...	...	...	...	...	...	...	...	...	...
,,		Ballyshannon	3·35	...	·55	26	17	...	...	...	...	...	...
XXIII		Waringstown	3·73	...	1·30	26	17	75·0	1†	40·0	8,28	0	0
,,		Edenfel Omagh)	3·94	...	·94	26	17	69·0	13	33·0	28	0	...

* And 19. † 12 & 18. ‡ 9 & 11.

+Shows that the fall was above the average; —that it was below it.

METEOROLOGICAL NOTES ON SEPTEMBER.

ABBREVIATIONS.—Bar. for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; T S for Thunderstorm; R for Rain; H for Hail; S for Snow.

ENGLAND.

LINTON.—A remarkably fine, dry, hot month, up to the 22nd; the 18th being, with one exception, the hottest day in the year; after the 22nd it was mostly showery, with now and then brisk but not high winds. Distant T on 20th and 25th. Ther. indicated above 80° on the 8th, 17th, 18th, 19th, and 20th, while only on the last two nights did it fall below 50°. The bar. unusually high during the fine weather, fell to its lowest point on the 26th. Heavy dews frequent, but few fogs, and taken altogether it has been the finest September since the same month in 1865, which was warmer towards the end than this has been.

SELBORNE.—Fogs on most mornings, but generally disappearing before noon. The finest show of hops for the last 20 years, but greatly deteriorated since about the 20th, and in some of the gardens quite spoilt. Prevailing winds, from 4th to 17th, N., N.E., and N.W., thence to the end S.W. Faint L on 16th, at 7 p.m. T S and R at 3.30 p.m. on 19th; L at night on 25th; very high wind from S.E. on 27th, and T in after part of the day.

BANBURY.—Fog on 6th, 10th, and 11th; TS on 19th, and at 1 a.m. on 25th.

CULFORD.—Very dry weather up to the 21st. Easterly winds during 14 days, and severe T S on the 28th. Mean temp. of the month 58°·7.

BODMIN.—Average temp. 63°·3. R rather more than double the average of the last 26 years, and the heavy fall (2·74 in.) on the 17th has only been twice equalled here during that period.

HAUGHTON HALL, SHIFNAL.—After a copious rainfall on the 2nd, little fell till the 18th, the weather then delightful, allowing the gathering of the latter harvest in tolerable condition, but the wheat crop sadly deficient in yield. On the return of the R it fell daily, with the exception of the 25th, to the close, and on the evening of the 19th most violently, accompanied by a storm of T and L, more terrific than ever known here; the L both forked and sheet; so continuous that scarce a minute intervened. The rainfall was ·83 in. A heavy gale from S.W. on night of 26th; fog early on 8th, 20th, and 21st; easterly winds from 12th to 24th, all the rest from S.W., W., or N.W. Small tortoiseshell butterflies very numerous; scarcely a peacock or red admiral to be seen. Sand martins all gone on 17th. Still no mushrooms at the end of the month.

LEICESTER.—Very fine till the 20th; much lightning on the evening of the 19th, and a severe T S, at 1 a.m., on 25th.

BOSTON.—Very heavy gale on 24th, at night, and lightning; very stormy on 26th.

GRIMSBY.—A fine warm month; great quantities of fruit blown down by the storm of the 26th. Foot and mouth disease very prevalent. A very brilliant meteor seen at 8.30 p.m. on the 14th.

MANCHESTER.—T S on 8th, with 1·00 in. of R, and another on 19th.

ARNCLIFFE.—T S on 8th, with 1·22 in. of R, and T S on 19th.

NORTH SHIELDS.—T S on 8th, with ·71 in. of R, max. of month. T S on 20th; L on 24th; very high wind on 26th.

SEATHWAITE.—Exactly 6·00 in. fell during the first two days; L on 18th, and T S on 19th, but with little R.

WALES.

HAVERFORDWEST.—Although there were three rainfalls exceeding an inch this month, yet it was a fine month for harvest operations, and in excess of temp. for September. A very stormy period set in on the 18th, and continued with constant R and violent gales to the end of the month. On 2nd R commenced at 0.30 p.m., continuing till 9 p.m.; the fall in that time was ·71 in., R still fall-

ing; at 1 a.m. of 3rd, R falling in torrents, and again at 4 a.m.; total fall 1·81in.; 18th, more than ·50 in fell in half-an-hour; total fall 1·12in.; 21st another heavy fall, 1·06 in. These heavy falls caused the total for the month to be 2·58 in. above the average, but till the 21st there were nice dry periods between the falls, so rendering it a fine harvest month.

LLANDUDNO.—T S at 5 p.m. over the sea on 9th. A splendid meteor seen on 14th; sheet L on 16th, and TS on 17th; hurricane during night of 26th. Weather fine first three weeks. Temp. and R above the average.

SCOTLAND.

DUMFRIES.—Total fall double the average; 1·88 in. fell on the 2nd, being the heaviest fall not only of the month, but of the year; beginning and end of the month very wet; a period of fine settled weather in the middle of the month; no T. Temp. 2° higher than last year. Wind S.W. and W. during the last week.

HAWICK.—Heavy rains on 3rd (Teviot flooded), 8th, and 20th; squally from the 24th to the 30th. Potato disease bad in this district, and in the town of Hawick the scarlet fever has been very prevalent, and in many cases fatal.

ANNANHILL.—Bar. pressure higher than last month; temp. 4° lower. Rainfall heavy, 2·24 in. fell on 26th; great floods all over the country on the same night; and great storm from W.N.W. with T and L, the gale in some of its gusts reached 70 miles an hour, and a pressure of 25 lbs. to the square foot, the first gale of the autumnal equinox; ozone scarce. Good harvest, most of the fields in the lower district being cleared and the grain secured by the 15th. Foot and mouth disease among the cattle still prevalent, but less virulent. Death rate 18 per 1000 per annum; number of fatalities 36, the smallest number in any month since May, 1872; principal causes bronchitis and scarlet fever.

CASTLE TOWARD.—A dull month throughout, with little sun, heavy clouds and strong gales; towards the middle the weather broke up, and with sharp winds the cutting and ingathering of the crops went on rapidly, and the yards are now beginning to look comfortable for the coming winter; potato disease prevalent in this district; fruit of all kinds has been plentiful; turnips looking very well. Foot and mouth disease still prevalent among the cattle.

BRAEMAR.—A month of fine weather, with the exception of the usual equinoctial gales, which occurred on the 27th, accompanied by T and L from 2 to 5 a.m.

ABERDEEN.—Bar., temp., and rainfall all above the average, wind pressure rather below it; a month of mild, wet, and generally quiet weather, but heavy gales from 24th to 27th inclusive. On the 27th, the wind from 1 to 10 a.m., was terrible, some of the gusts rising fully to 12 (Beaufort). Fogs frequent, and heavy dews; T and L 4 to 7 a.m., amid dense fog, on the 9th; distant T S on 19th; T S 4 to 6 a.m. on 27th, the bar. being then at its lowest point.

LOCHBROOM.—The finest harvest month for 20 years; 16 continuous days without rain at this season is a valuable boon; the crops are all safely secured. The potato crop good.

PORTREE.—The finest September since 1868; the crops (except in patches on very late farms) secured in fine condition. Heavy gale from W.S.W. on 25th, from 5 to 7.30 a.m.; a heavy hailstorm on 27th, solar halo all day on 22nd.

SANDWICK.—Fine month, nearly all the rain falling on 26th.

IRELAND.

DARRYNANE ABBEY.—First half fine, having only four days wet; total fall 2·21. Second half very wet, being 8·40 in 13 days; the total 10·61 is much in excess of any month I have recorded, and the fall on 21st, 2·13, is the heaviest I have registered on one day, the nearest to it was 2·08, on September 1st, 1870; 6·19 fell in the 7 days 21st to 27th. All the rivers were much flooded, but no damage done by them, being short they fall on the slightest lull in the rain.

KILLALOE.—Tremendous floods on 26th, and much damage done to hay aud corn.

MONKSTOWN.—Heavy squall of wind and rain about 4 a.m. of 3rd; from 1st to

18th remarkably fine and bright, mornings cool and frequently foggy; 19th to the end rain almost continuous, though not very heavy.

BALLYSHANNON.—The month has been marked by heavy falls of rain of short duration, and strong easterly and southerly winds have been frequent; bar. unsteady throughout. Crops abundant.

OMAGH.—Weather up to 15th very fine and favourable, permitting as favourable a harvest as has been known within living memory to be secured in excellent condition; the remainder of the month strong squalls and unsettled weather, with occasional heavy rains.

THUNDERSTORM, SEPTEMBER 19TH.

To the Editor of the Meteorological Magazine.

SIR,—I was at Malvern on Sunday evening, and can bear testimony to the remarkable kind of lightning, exactly corresponding to the report of it by "R. H.," of whose letter in the *Birmingham Daily Post* of to-day, I enelose a copy. I think you will say it is worth reading.—Yours truly,

JAS. NUTTER.

Cambridge, Sept. 21st, 1875.

[Yes, and probably our readers will think so too.—ED].

To the Editor of the "Daily Post."

Sir,—A very remarkable thunderstorm came over the Selly district yesterday evening, being the eighteenth of this season, which I think merits a more minute description than that contained in your paper of this morning.

The day had been intensely hot, with scarcely a breath of air to relieve it. The afternoon became lowering, and it was evident that a tempest, as it is called, was impending. Between five and six o'clock a few precursory drops began to fall, and suddenly the whole expanse of sky was overspread with dense billowy clouds, which reduced us almost to darkness.

What is most remarkable about this storm was the great disproportion of the thunder to the lightning discharges. The latter were most brilliant, sometimes terrific. First came a flaming red ball, the ball being the nucleus, with a long comet-like tail, descending in the usual zigzag fashion, but attended with little or very faint thunder. After such a brilliant electric discharge you would have expected a crash as if the heaven and earth were coming together. Then would come a flash of sheet-lightning, lighting up the landscape like day, these flashes being followed and interspersed with a succession, at very short intervals, of some of the most beautiful coruscations of light my long-experienced eyes ever beheld. Every few minutes it literally showered electric balls of fire—splendid white light, strangely enough followed, not very quickly, by only slight rumbles of thunder. It also seemed strange that though the cloud must have moved on in the direction the storm was taking, all these discharges seemed to fall at about the same place, suggesting a strong feeling that, if there were any inhabitants about there, they were in some danger; and the direction was that of Edgbaston. I sat for fully half-an-hour watching this fascinating sight, and "soothly swore" that I never saw a more brilliant pyrotechnic display. Memory cheats us sometimes, but I thought at the time it was the most striking sight I had ever seen.

It may be remarked here that the present year is a strong parallel as regards thunderstorms with that of 1872. That singular year, both for storms and rain, had seventeen between April and July, and some three or four afterwards. This is the eighteenth of this season, of more or less intensity, from May to September inclusive.

September 20, 1875. R. H.